How Research and Development can Help Advance Distributed Generation

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Overview

- Public Interest Energy Research (PIER) Program
- Active Research and Development Activities
- Future Research and Development Activities

PIER Smart Grid Research Ongoing at all Levels

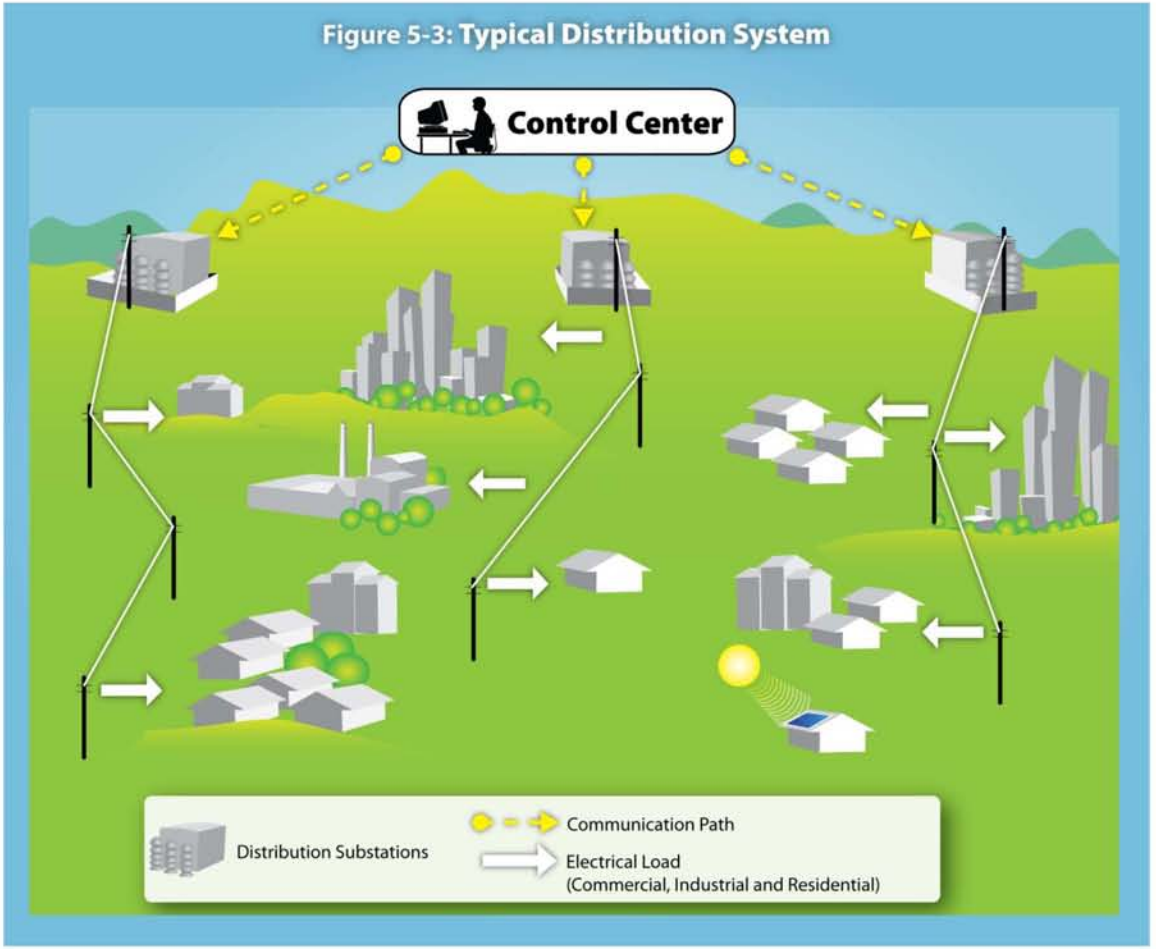
- Phasor Measurement
- Advanced displays
- Advanced comm & controls
- MRTU interface
- Energy Storage
- Renewables

- Distribution Automation
- AMI
- Advanced C&C
- MRTU
- Energy Storage
- Renewables

- Renewables
- Standards
- Protocols
- Reference designs
- Micro Grids
- Automation
- Energy Storage

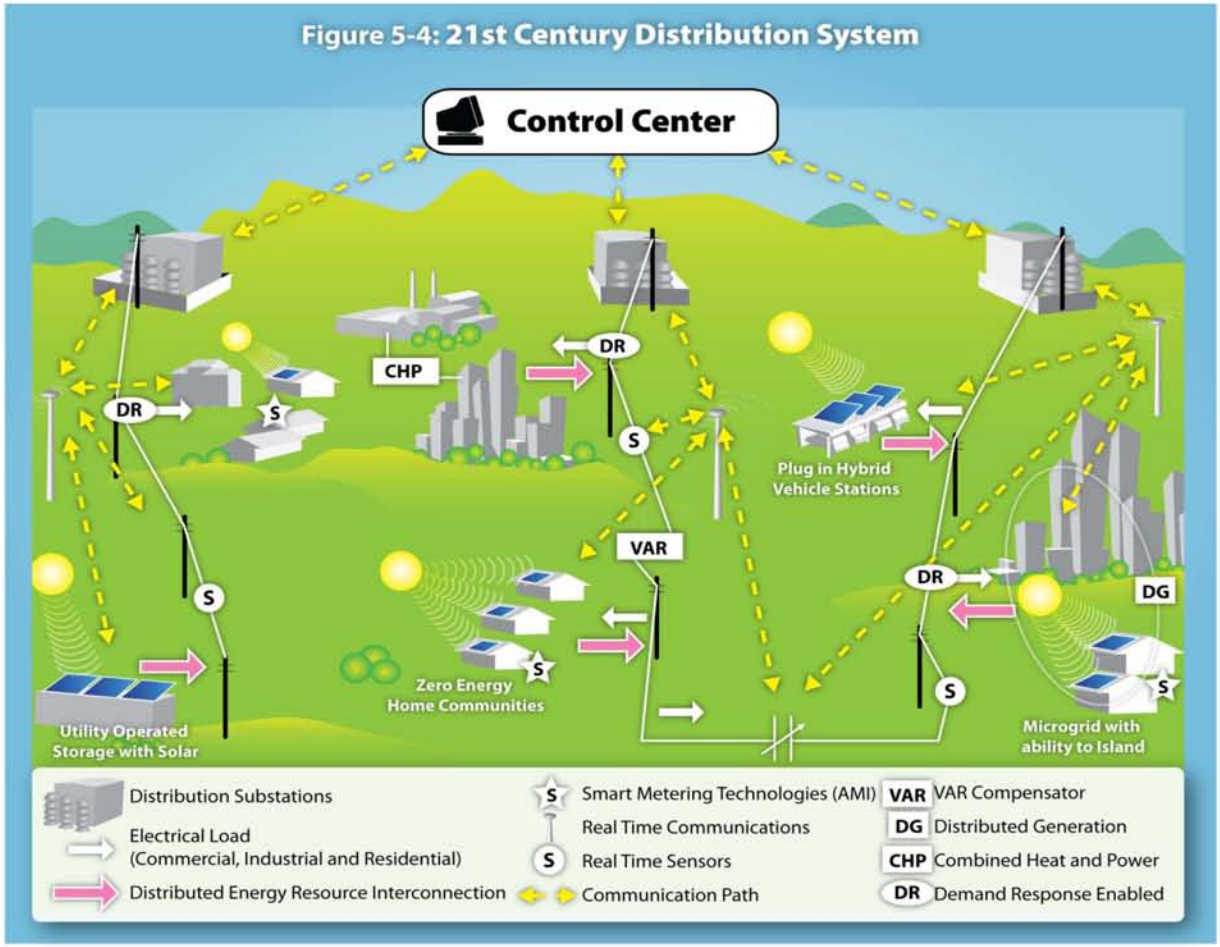
- Automating Demand Response
- AMI
- Dynamic Rates
- Home Area Networks
- Plug in Hybrids
- Renewables
- Energy Storage

Strategic View – Utility Grid of Today



Source: 2007 IEPR

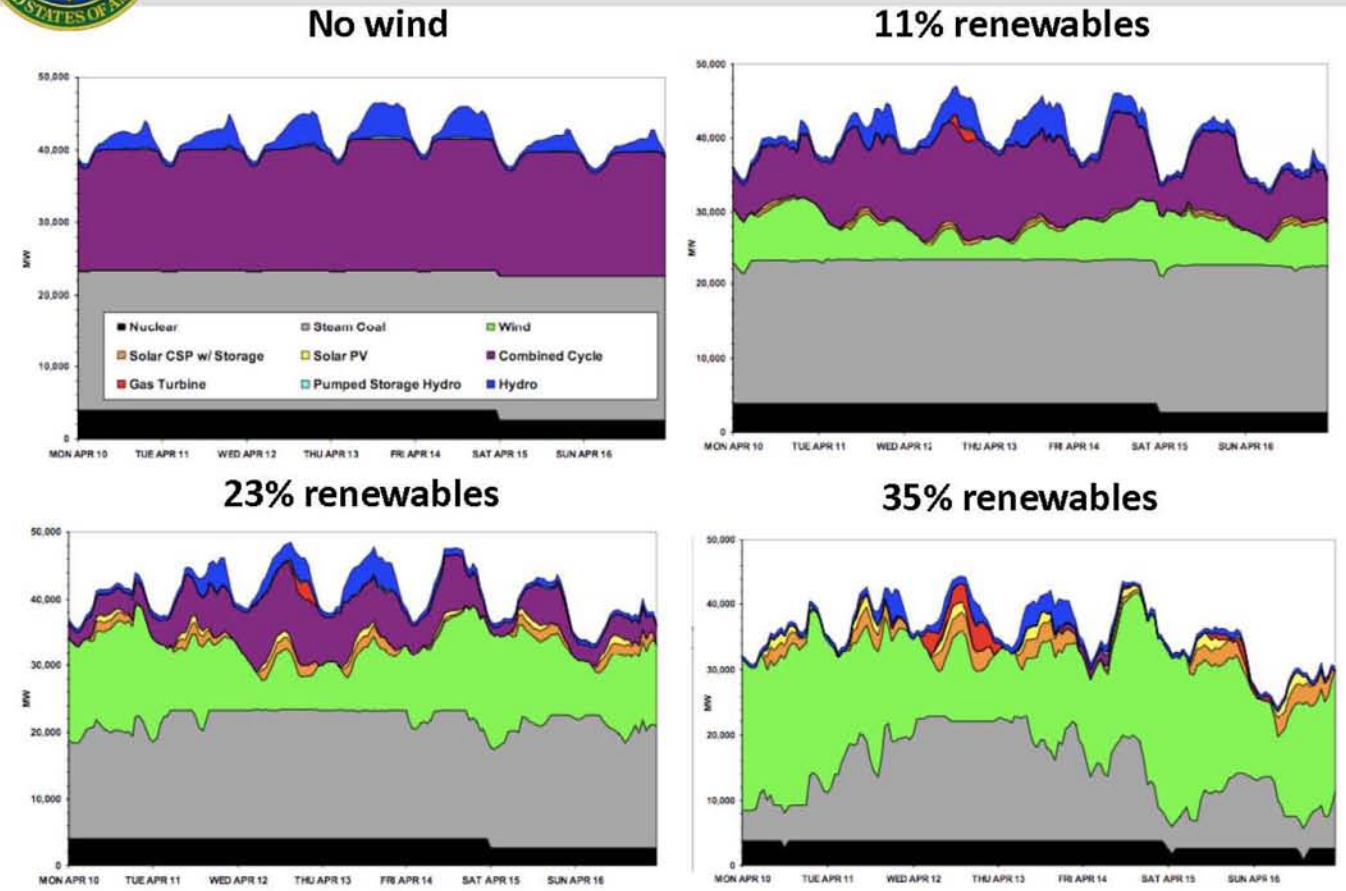
Strategic View:
Utility Grid of the Future (Smart Grid)



Source: 2007 IEPR

Future Grid Challenges

OE - Variable Generation Affects Grid Operations



Lew et. al. "How do Wind and Solar Power Affect Grid Operations: The Western Wind and Solar Integration Study". National Renewable Energy Laboratory. (September 2009). p. 6

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California ISO
Your Link to Power

2013 Solar Ramps will be an issue to manage

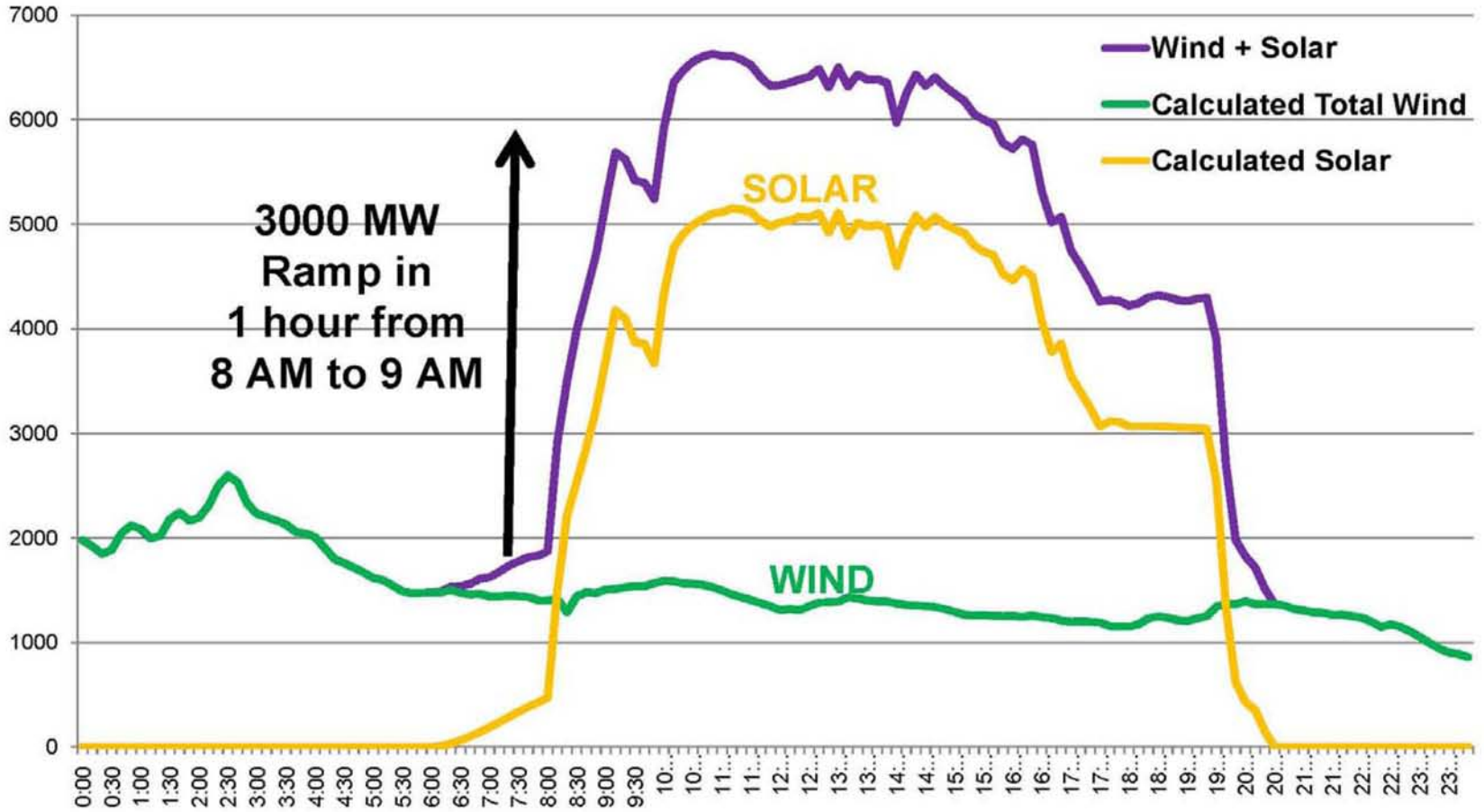


Chart based on March 2010 actual data and escalated to amount of renewables expected in 2013

General Approach

TECHNOLOGY ELEMENTS TECHNOLOGY INTEGRATION SMART GRID

Underground Cables

Phasor Measurement

Flywheel Energy Storage

Automated Metering Infrastructure

Demand Response

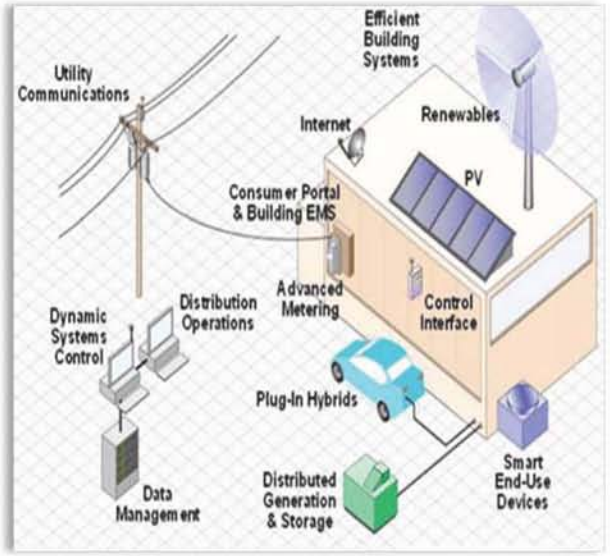
Pole Top Transformers

Research Focus on Developing & Improving Devices

General Approach

TECHNOLOGY ELEMENTS TECHNOLOGY INTEGRATION SMART GRID

- Integration of renewables, PHEV's, and electric energy storage devices
- Grid more reliable and efficient
- Micro Grid scale research
- Partner with Utilities & National Laboratories

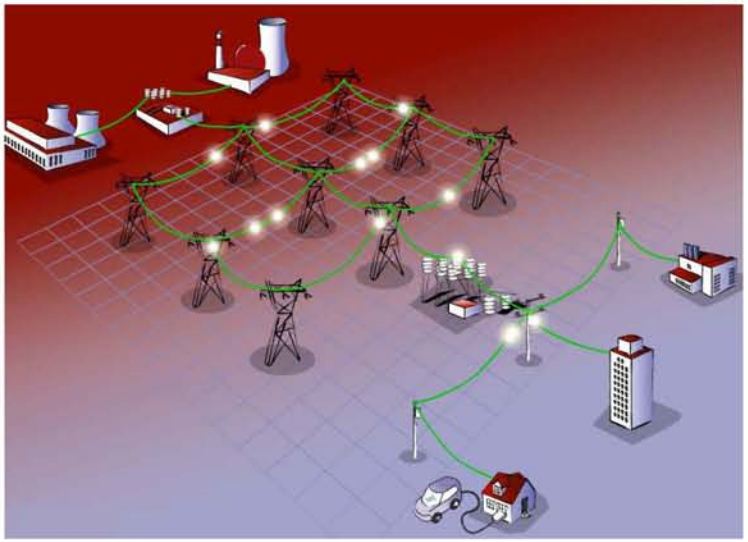


Research Focus on Integration of Devices into a grid system

General Approach

TECHNOLOGY ELEMENTS TECHNOLOGY INTEGRATION SMART GRID

- Large scale integration of renewables to meet RPS goals (33%)
- Plug-in-Hybrid's/Electric Vehicle's
- Electric Energy Storage/Auto DR
- More Reliable & Efficient Grid
- Community & Multi-Utility scale project



Research Focus on Entire Grid System

On-Going Research

- **Storage**
  - ✓ More than 12 projects (ARRA included)
- **Automated Demand Response**
  - ✓ Ancillary Service
- **Distribution Impacts**
  - ✓ Electric Vehicle Simulator
- **Forecasting**
  - ✓ Short term forecasting (less than 1 hour)

On-Going Research

- **Microgrid Visibility to CAISO**
  - ✓ Providing operation oversight of a microgrid to CAISO
- **Electric Vehicle Integration**
  - ✓ DC Charging from PV (improved efficiency)
- **Distributed Electric Storage System**
  - ✓ DC charging of Storage System from PV (improved efficiency)
- **PV Clustering**
  - ✓ Determining best placement of storage to mitigate renewable impacts

ARRA Smart Grid in California

Total Project Value to CA - $1.3 Billion

- City of Glendale Water & Power
- Modesto Irrigation District
- Burbank Water & Power
- City of Anaheim
- Electric Power Group (WECC sub-contractor)
- Pacific Gas & Electric (WECC sub-contractor)
- Sacramento Municipal Utility District
- San Diego Gas & Electric
- Honeywell International, Inc. (Headquarters in MA, work being done in Southern CA)
- Los Angeles Department of Water & Power
- Southern California Edison
- Boeing (Headquarters in MO, work being done in Sunnyvale and Huntington Beach, CA)
- Waukesha Electric Systems (Headquarters in WI, work being done in Irvine, CA)
- Primus Power
- SEEO Inc.
- Southern California Edison
- Pacific Gas & Electric
- Amber Kinetics
- Ktech Corp. (Headquarters in NM, work being done in Sunnyvale and Snelling, CA)
- Sacramento Municipal Utility District (sub-contractor to Premium Power, Headquarters in MA)

Energy Storage Technologies Applying Smart Grid Technologies

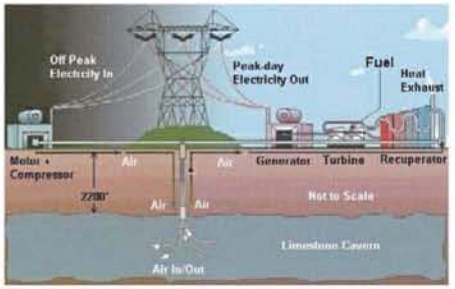


Photo Courtesy of CAES Development Company

Photo Courtesy of Saft America

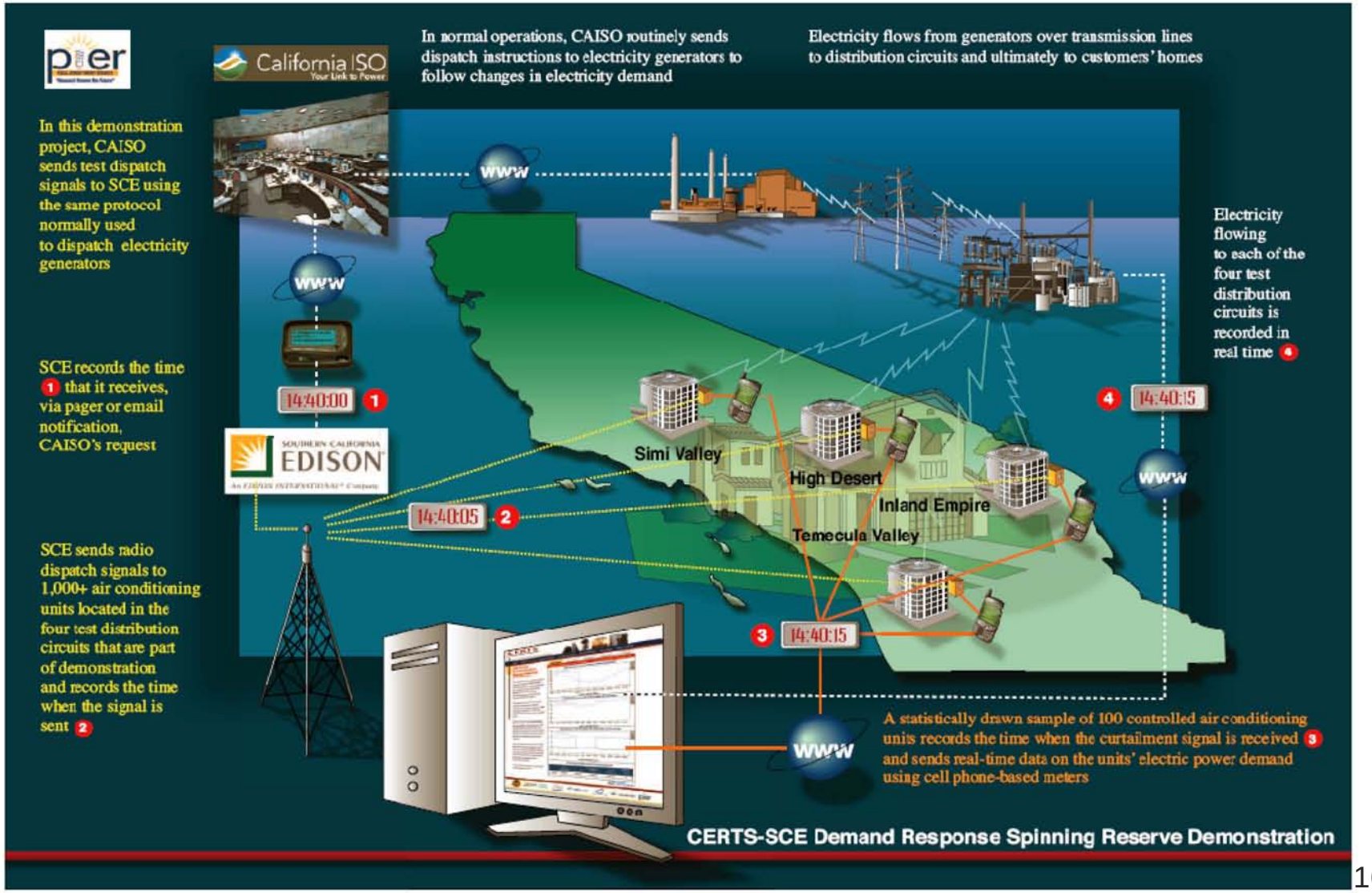
Demand Response Automation by Sector

Communicating Thermostat

Demand Response Automation Client

Demand Response Automation Client

DR as Spinning Reserve or Ancillary Service



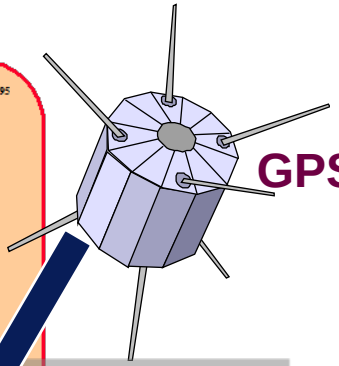
Future Research

Distribution Research To Meet Goal of 20,000MW

- Characterization of sample feeders
- Local DG impact assessment
- Information sharing /build partnerships
- Coordinated data analysis
- Feeder modeling for future DG and EV impact predictions
- Implementation of broader feeder monitoring where indicated
- Distributed resource behavior specifications
- Distribution system Research Road Map

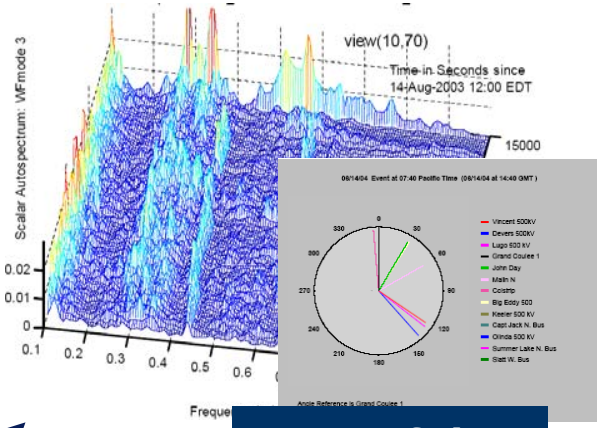
Synchrophasor Measurement – The Heart of the Smart Grid Transmission

PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

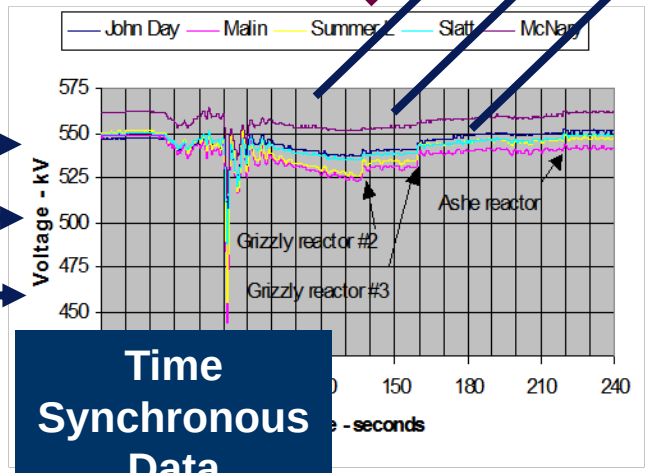


GPS Satellite

Time-Stamp



Data

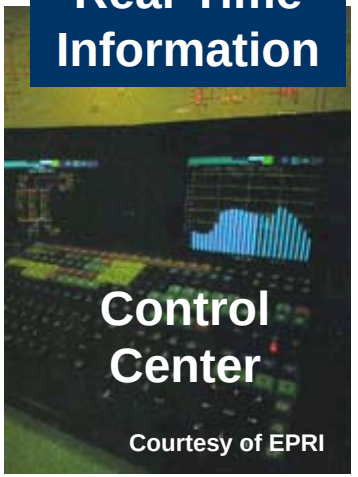


Data

PMUs (Phasor Measurement Units)

Time Synchronous Data

Useful Real-Time Information



Ultimately, Smart Grid required for maximum renewables deployment.

Future Research

Integrating Demand Response & Energy Storage

- **DRRC:**
  - ✓ Open Automate DR
  - ✓ National Standards Development
  - ✓ Estimating 2020 Capabilities
- **Lawrence Livermore National Lab**
  - ✓ Modeling Entire California Grid
  - ✓ Assessing Energy Storage/Auto-DR/New Generation Needs
- **Energy Storage**
  - ✓ AB2514 Activities
  - ✓ California ARRA Energy Storage Projects
  - ✓ Assessing Energy Storage Need to Meet RPS

Follow-up Questions

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